

# *HyPower*

*Customers magazine for Voith Siemens Hydro*

*November 2003*



## Summary

## Editorial

### Editorial

- 3 The future of hydro power: back-up against blackout.

### Focus on Africa

- 4 East African countries liberalize their energy sectors
- 6 Gilgel Gibe on the way
- 8 Improved power generation reliability in Tanzania
- 10 80 MW unit added to Gitaru in less than two years

### Market splinters

- 12 Another Indian milestone: Omkareshwar
- 13 Baspa II, India  
Largest private hydropower station connected to the grid
- 14 Successful model acceptance for Tai'An, China
- 15 Operation training for Middle Marsyangdi, in Nepal

### Partnering and project expertise

- 16 Partnering with Hydro Tasmania in Gordon modernization
- 17 Aimorés, Brazil, begins operation

### Expertise in automation

- 18 Last step to digital governors at Danube hydropower stations
- 19 New control system for Germany's Friedrichsau

### Technological leadership

- 20 Opening ceremony at Europe's most modern pumped storage plant
- 22 Research to reduce hydro-abrasive wear

### Customer contacts

- 24 Infra 2020: Sponsoring the third Brazilian Forum of Electric Energy

ERLAC X prizes for best paper presentations

New brochures

- 25 Waterpower XIII, 2003 – Very well attended

Voith Siemens Hydro, USA, names new officers

### Essay

- 26 The sound of the waves

# Voith Siemens Hydro Power Generation

*The future of hydro power: back-up against blackout.*

Dear readers, dear customers,



*Dr. Hubert Lienhard  
Chairman of the Board  
of Voith Siemens Hydro  
Power Generation*

The recent blackouts in parts of the United States, Canada, Great Britain, Denmark and Italy revealed something that was unexpected by the general public of these and other industrialized countries: We are fast approaching the limits of grid capacity, stability and reliable electricity delivery to an extent that is remarkable for post world war II times.

Have any industrialized countries experienced much more than flickering of light during the last 40 to 50 years, except for emergency situations such as severe weather? Did we experience regular power outages or interruptions of electricity supply?

No. It is a given that a developed and industrialized society experiences an endless supply of undisturbed and safe electricity.

Reading the many responses and comments following these blackouts, you might have noticed that hydropower stations, especially during the Northeastern blackout in North America, were able to continue operation and stabilize their grids or bring them back on line much faster.

We were especially proud that customers rewarded us with some direct comments regarding the performance of our machines. A telephone call on the 15th of August between our staff and Al Zelinski from St. Lawrence hydropower station of the New York Power Authority (NYPA) confirmed that "unit no. 26 reverted to speed control unsynchronized mode of operation [this is the most stable governor control mode] as you [Voith Siemens Hydro] designed it to do and then ran 'rock solid' for the remainder of the incident". Further, he mentioned how much better it would have been if NYPA had 16 unit "26" in service instead of only one.

Only hydro power can provide capacities and offer the many ancillary benefits that easily match or pass other fuel types in generation. One of its great attributes is to provide quick and flexible connection or disconnection to the grid, and for this reason, it is ideal to balance peak or low load demand from the grid in large capacities.

Future electricity supply can only be safe and reliable, if the energy mix in any country is done in a balanced concept to provide the power needed, with environmentally optimum solutions, and meet Kyoto green gas reduction goals at the same time.

Not an easy task: hydro power stands by – and so do we as a supplier – to support operators, utilities and decision makers with the advantages it has had for hundreds of years and to still develop solutions that make this fuel even more environmentally friendly.

Whether this happens in Africa – the market focus of this issue – or other areas, we are always available to help you.

Whatever your opinions and business interests are: please do not hesitate to let me know what they are!

Yours sincerely



*Dr. Hubert Lienhard*

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# East African countries liberalize their energy sectors

Energy is a basic requirement for human development, yet over 70% of people living in rural East Africa have no access to grid electricity or any other form of modern commercial energy. Even though East Africa's potential for hydro power is high, only a fraction is developed. Hydro power projects are capital-intensive, one reason why African governments are not undertaking them as fast as they could. The deregulation and liberalization now taking place within the energy sectors of East African countries such as Ethiopia, Kenya, Tanzania aim especially at attracting private investors, who are also prepared to consider the development of small hydro power potential.

### **Ethiopia – The water tower of Africa**

Ethiopia occupies an exceptional position in tropical Africa. Well-irrigated highlands and rivers abounding in water, which fall from great elevations into canyon-like valleys have given this country the reputation of the "water tower of Africa". Its economically feasible hydropower reserves (an estimated 260,000 GWh/year) far exceed its own needs. These are ideal conditions for supplying the energy-starved neighboring countries. However, less than 2% of the precious hydro potential has been developed. Less than 15% of the population has access to electricity. In addition, there are ambitious plans to develop the food processing industry, the mining sector and the tourism sector, all of which will rely on electricity.

The government has recognized the fundamental importance of sustained, reliable energy supplies for the development of Ethiopia's economy and that of its neighboring countries, and has begun an extensive reform of the energy market. The liberalization of the market is above all intended to attract private investors.

Because domestic and more particularly industrial energy consumption is low in Ethiopia, regional integration and the interconnection to other national power grids is paramount. With the completion of different hydroelectric projects, which are now up and running, and the implementation of power projects by the private sector, Ethiopia would have excess power for possible export. In addition,



cooperation in sharing the Nile resources has been extended, with nine of the ten Nile basin states participating.

### **Tanzania – The Country of the Great Lakes**

Tanzania is bounded in the North by Lake Victoria, in the West by Lake Tanganyika, and in the South by Lake Nyasa, plus the inland lakes, including Rukwa, Manyara, Eyasi and Natron. In addition it has many rivers with the main river basins Rufiji, Kagera, Malagarasi, Ruvuma, Pangani, Wami and Mare and several coastal rivers, of which all have hydropower potential, most of it undeveloped.



Agriculture dominates Tanzania's economy, accounting for 56% of the Gross Domestic Product (GDP), providing 85% of exports and employing 90% of the work force. Cultivated crops are, however, limited to only 4% of the land area. Industry accounts for 15% of the GDP and is mainly limited to processing agricultural products and lighter consumer products. Yet current energy production does not meet demand. Many rural regions have no access to electricity. The economic growth, which is necessary to guide the country out of poverty, is also lacking.

The Ministry of Energy and Minerals is responsible for all energy-related matters in Tanzania. Under the Ministry, Tanzania Electric Supply Company Ltd. (TANESCO), a state owned company, was formerly the only company responsible for generation, transmission and distribution of electricity.

Tanzania has also realized that a dependable electricity supply is essential for economic growth and decided to deregulate the energy sector and to allow private investment.

Tanzania has an estimated hydropower potential of 4,000 MW, of which only about 14% has been harnessed so far. The exploitation of the hydro-power energy still untapped would definitely help Tanzania and other neighbouring countries foster economic growth and support the countries' poverty reduction efforts.

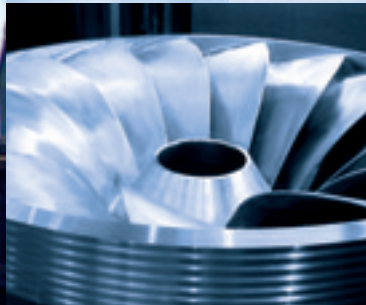
#### **Kenya – development based on hydro power**

The Kenyan government has been successfully implementing a program of economic liberalization and reform since 1993. Deregulation has helped to boost most sectors of the economy and to attract private capital.

Kenya's energy program is largely backed by foreign investment. However, electrical shortages remain a key barrier to development within the country.

At present, around 80% of power supplied in the country is generated from hydro power stations. Most hydro potential is found on the Tana and Turkwel rivers. It is estimated that the technically feasible hydro potential is 4,710 GWh/year, of which 62% has been developed. No new hydro plants are currently under construction, but existing facilities have potential for upgrading. On the other hand, there are several small, mini and micro hydro plants in operation, with a total capacity of around 14 MW, being considered for development by private investors.

## *Gilgel Gibe on the way*



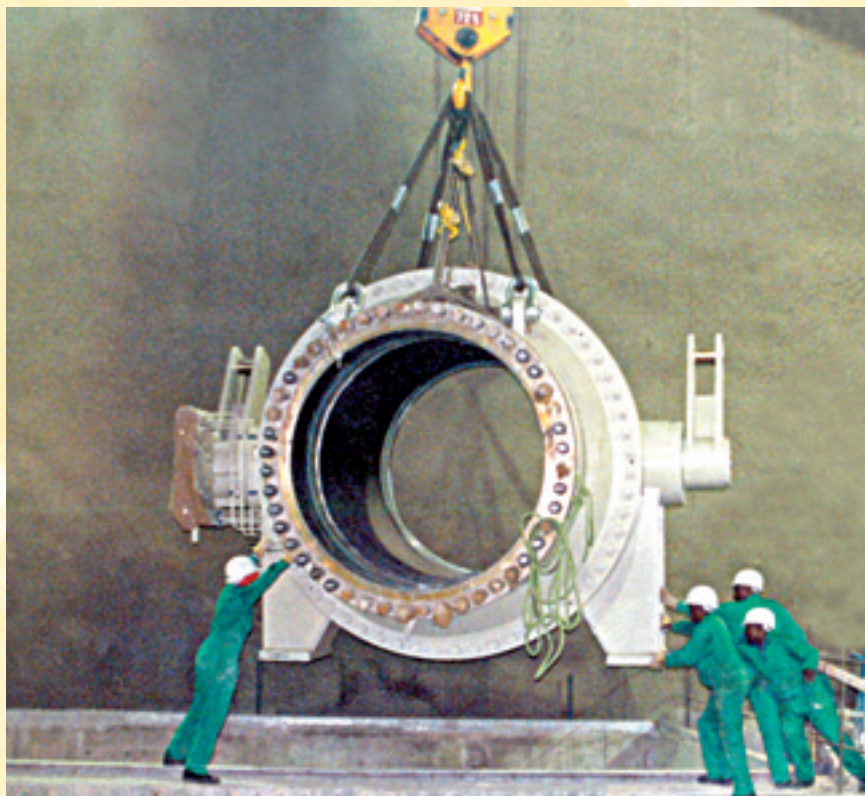
The 184 MW Gilgel Gibe hydropower project is located in south central Ethiopia, about 270 km from Addis Ababa. Upon completion, the project will contribute about 40% of the present installed capacity of the country. The operator is government-owned Ethiopian Electric Power Corporation (EPCO), the main financier is the World Bank group (IDA) along with the European Investment Bank (EIB) as a co-financier. The construction work on the powerhouse, tunnel and dam is now nearing completion. The commissioning of one of the three units is expected in November 2003. Voith Siemens Hydro is responsible for the mechanical design, manufacture, delivery, erection and commissioning of the three 66.7 MW Francis turbine units, including the digital governor system and turbine inlet valves.

An intensive training for a group of ten EEPKO staff was held in spring, 2002, at Voith Siemens Hydro in Heidenheim. In addition to traditional training on design, manufacturing, control, erection, commissioning, operation and maintenance, following issues were also part of the agenda: quality and procurement processes, bearing behavior as well as general mechanical and electrical features. The group also witnessed the approval of the first runner and guide bearing for Gilgel Gibe, manufacturing quality assurance demonstrations such as tensile and bending testing, and paid a visit to the hydraulic testing lab. The training was rounded up by excursions to small hydropower stations, some bulb installations and also a site visit to Germany's impressive Goldisthal pumped storage stations.

The training agenda was tailored to exact customer specifications and specific requirements for the future operation of the plant.

Voith Siemens Hydro is very pleased with the results of the complete project and is looking forward to continuing the good relationship developed with EEPKO on their second stage hydropower station at Gilgel Gibe.

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# *Improved power generation reliability in Tanzania*

The 200 MW Kidatu Hydropower Station in Tanzania, owned by TANESCO (Tanzania Electric Supply Company Ltd.), was built in two stages, with two units being commissioned in 1974 and two more in 1978. Over the years, the control system underwent various rehabilitation programs and extensions, resulting in a conglomeration of systems that made service and maintenance of the plant extremely difficult. Voith Siemens Hydro of Norway has recently completed a total replacement of the existing outdated automation, communication and protection systems.

## **Automation**

Voith Siemens Hydro engineers replaced all parts of the existing control system with a state-of-the-art automation system and a PC-based Man-Machine-Interface (MMI). The generating units, auxiliary systems and the switchyard were equipped with autonomous Unit Controllers (UC) on which all the unit-specific software runs.

To get accustomed to the new system, the power plant operators were given basic and advanced computer and system training by Voith Siemens Hydro. During the implementation period, the staff was able to get a good grasp of the new technology. This advanced training with the well-proven Voith Siemens Hydro technology enables the smooth operation of the power plant.

## **Water Household System**

One part of the automation system is the advanced Water Household System. This is a special online software system implemented on the standard automation hardware. Among other things, the system consists of online joint control and power generation planning, including the consideration of start and stop costs, etc.





After a short period of operation, the Water Household System has significantly improved the average energy output of the power plant, and the extra investment has already paid for itself.

#### **Protection**

The SIPROTEC family from Siemens was chosen as the new protection system. Each unit has been equipped with duplicated electrical and mechanical protection systems based on state-of-the-art, self-monitoring standard equipment.

Voith Siemens Hydro has prepared a Relay Coordination Study for the whole scheme. Due to the new protection scheme of Kidatu, grid stability and power supply reliability in Tanzania are improved noticeably.

#### **Communication**

Due to technology failure, poor maintenance, landslides and bushfires, all communication between the powerhouse, dam and switchyard had broken down. Voith Siemens Hydro specialists, together with the client, evaluated several ways to solve the problem and decided to install a power line carrier system (PLC).



The necessary work on the important transmission line was planned in detail and completed during a very short shut-down and interruption of the power transmission. With its new equipment, the automation system is already on-line with the remote control communication to the TANESCO Load Dispatch Center.

#### **Documentation**

The last, but not the least important part of the rehabilitation project, was

the improvement of the plant documentation system. All information is now compiled in one comprehensive documentation system. From now on the operation and maintenance staff can get a clear overview of all details in a short time and perform necessary services more effectively.

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## 80 MW unit added to Gitaru in less than two years

The Gitaru power station is located on the Tana River, about 160 km north east of the Kenyan capital, Nairobi. Owned and operated by Kenya Electricity Generating Company Ltd. (KenGen), the plant with its two 72.5 MW vertical Francis units began commercial operation in 1978. In this initial phase, the civil design and construction had already made provisions for a third unit. Nevertheless, it was not before the second half of the 1990s, when Kenya's electricity demand began to exceed supply, that the decision to install additional generating capacity was taken. A third machine would provide additional energy during the rainy season, give year-round peaking power and increase KenGen's operational flexibility.

When tender documents for international competitive bidding were issued in 1997, a very ambitious time frame outlining an implementation period of just 25 months was proposed. For a project of this magnitude, the time frame seemed unachievable. Voith Siemens Hydro accepted the challenge and promised an even faster project implementation of just 22 months.





### **Simultaneous work to reduce implementation schedule**

The machines at the Gitaru plant rank among the largest generating units in the Kenyan system. The combined rotor-shaft weight of the original 72.5 MW machines reaches approximately 175 tons. The additional vertical-shaft Francis turbine-generator unit, which Voith Siemens Hydro was to install, was designed to be capable of delivering an even higher maximum continuous output of 80 MW. Since typical erection programs for machines of this size can easily take 30 months and more, it was necessary to reconsider the traditional erection sequences. As the single turnkey contractor, Voith Siemens Hydro was responsible for the timely and efficient management of all critical aspects of the project

including design approvals, interfacing with existing station systems and relevant Kenyan regulatory authorities as well as customs clearances through the port of Mombasa. To guarantee minimum duration, simultaneous turbine and generator erection activities were maximized and the impact of the civil works on them minimized. A close management of all activities and subcontractors involved was essential to the success of the project.

### **Flexible project management secures final success**

Late into the project time line, it became clear that the civil works would be completed late. This created an even shorter time for the completion of the remaining turbine and generator build sequences and commission-

ing. In spite of these changing circumstances, Voith Siemens Hydro was able to adapt its original program accordingly and also cope with further delays caused by customs clearance problems. Dry commissioning of turbine-generator auxiliary equipment began in early October 1999. At the beginning of November the unit was watered-up and synchronized with the Kenyan grid. Commercial trials began in that same month – less than two years from the initial contract award.

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# *Another Indian milestone: Omkareshwar*



Voith Siemens Hydro, in consortium with Jaiprakash Industries Ltd., India, has been awarded the contract to supply and install the new Omkareshwar hydropower station. The 123 million Euro order covers the supply of all electromechanical equipment, including eight vertical Francis turbines and synchronous generators, each with a rated capacity of 65 MW, associated auxiliaries and a 220 kV outdoor switchyard. The project is located on the Narmada River in India's federal state of Madhya Pradesh. After commissioning in 2007, Omkareshwar will be among India's largest hydropower stations with a total installed output of 520 MW.

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# ***Baspa II: Largest private hydropower station connected to the grid***



At a formal signing ceremony of the commissioning certificates for the three units of the Baspa II hydropower station in India, the generators, supplied by Voith Siemens Hydro Power Generation, have been handed over officially to the customer, Jaiprakash Hydro Power Limited.

The Baspa II power plant has supplied electricity from the Himalayas into the Indian grid since June 2003.

With a maximum output of 360 MVA, the run-of-river plant at an elevation of 1,825 m is reducing the peak load shortage in the Federal State of Himachal Pradesh as well as in the Greater New Delhi area. Voith Siemens Hydro, as consortium leader had been awarded the contract to provide the com-

plete electro-mechanical and control equipment for Baspa II together with VA Tech in January 1999. Baspa II is the largest hydropower project in India operated by an IPP – an Independent Power Producer, Jaiprakash Hydro Power Limited (JHPL).

The award of this project marked the beginning of successful cooperation between two market leaders in the area of hydropower in India, Jaiprakash Industries, the parent company of JHPL and Voith Siemens Hydro.

Both companies signed a general cooperation agreement in November 2000. Recent orders for the hydropower stations of Baglihar and Omkareshwar (see left) show the continued success of this collaboration and also the substantial contribution of Voith Siemens Hydro to the development of hydropower potential in India.

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# Successful model acceptance for Tai'An

Another successful model acceptance test recently took place in the Corporate Technology facilities of Voith Siemens Hydro Power Generation. The model for the reversible pump-turbines for the new pumped storage plant Tai'An in China underwent extensive testing.

In the presence of experts of the customer, Shangdong Taishan Pumped Storage Power Station Co., Ltd., efficiency and other performances guaranteed, as well as proof of secure operation of the prototype could be best fulfilled. During a customer witness test with Shangdong Taishan Pumped

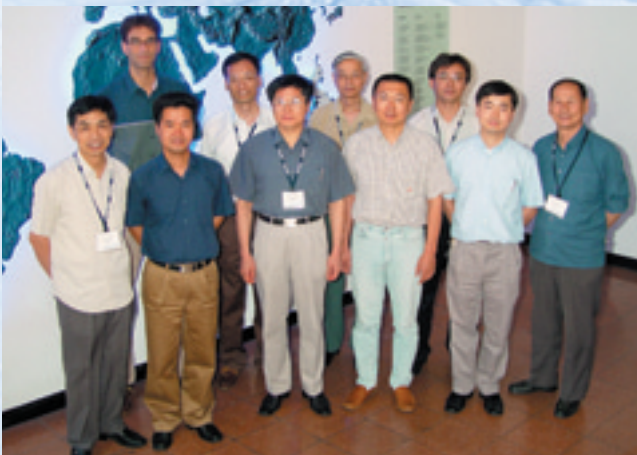
Storage Power Station Co., Ltd, all parameters guaranteed were met.

Tai'An hydropower plant will be equipped with four reversible pump-turbine units, each with an output of 250 MW. Voith Siemens Hydro was awarded the contract at the end of November 2002

and will supply four complete units: pump-turbines, motor-generators, spherical valves, supervisory and control systems.

The first unit is planned to be commissioned end of 2005.

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# Operation training for Middle Marsyangdi

**Nepal's most important energy resources are biomass and hydro power. Currently, the country relies on economic progress through tourism, the labor-intensive small and medium-sized industries and – in the long term – the export of electrical energy to India. At present, only approximately 1.5% of the country's commercially usable hydropower potential of around 25,000 MW is developed.**

Another hydropower station, Middle Marsyangdi, with an installed capacity of 72 MW, will be put into operation in mid-2005.

The turbines – two Francis turbines with a capacity of 36 MW each – and the inlet valves and controls are supplied by Voith Siemens Hydro. And not only these: the services provided also include the communication of expertise for the optimum operation of the plant after completion. Voith Siemens Hydro trainers gave their expertise on hydraulics, maintenance and process technology to four guests

of Nepal Electricity Authority during one month in Heidenheim. They deepened their new knowledge through visits in the Goldisthal and Glems hydropower plants. During the final exam 60 technical questions had to be answered. All trainees passed with flying colors. "We learned a lot during the four weeks and are now well-versed in operating our hydropower plant," said plant manager Sunil Kumar Dhungel.

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*Training on the job for the guest from Nepal*



*Middle Marsyangdi gates*

## Partnering and project expertise

# Partnering with Hydro Tasmania in Gordon modernization

An alliance agreement has been formed between Hydro Tasmania and Voith Fuji Hydro, Kawasaki, Japan, for the modernization and optimization of the hydroelectric equipment at Gordon power station, end of 2002.

Hydro Tasmania's Manager, Power Schemes, Simon Krohn, said that the project objective was to improve the reliability and availability of the machines in readiness for Hydro Tasmania's entry into the National Electricity Market. "Gordon power station will be a key asset in meeting peak load demands," Mr. Krohn said. "Since the power station was commissioned in 1978 it has served Tasmania as a base load station during periods of low rainfall, when generation from our run-of-the-river assets is also low. The refurbishment of these units will prepare them for their new role as a peak generation plant."

Mr. Krohn said that the alliance agreement with Voith Fuji Hydro has the potential to deliver better outcomes in a shorter time frame than traditional contract arrangements. As the president of Voith Fuji Hydro, Dr. Martin Kuechle adds: "Being the Japan based entity of Voith Siemens Hydro Power Generation, Voith Fuji Hydro is able to provide our customer, Hydro Tasmania, with the comprehensive expertise and state-of-the-art technology of the leader in hydro power modernization."

Hydro Tasmania is the largest renewable energy generator in Australia, owning and operating 2,262 MW of

hydro power plants. This project is one of a series of planned upgrade projects that are part of Hydro Tasmania's 10-year program of efficiency upgrades and refurbishments.

The Gordon power station generates energy from inflows into Lake Gordon and Lake Pedder in South-West Tasmania. With three 150 MW Francis turbines, it is the highest capacity power station in Tasmania.

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Lake Pedder



Wineglass Bay, Tasmania



# *Aimorés, Brazil, begins operation*



For Voith Siemens Hydro's Brazilian unit, the construction of the Aimorés power plant, located on the Doce River in the south eastern state of Minas Gerais, is one of the most important ongoing projects. All of the three Kaplan runners have already arrived at the site and the first machine will start operating in December. The project is progressing smoothly as scheduled. Once the last generating unit has begun operation in May 2004, the power station will have a total capacity of 336.75 MW.

Voith Siemens Hydro is carrying out the project under an EPC (Engineering Procurement and Construction) contract, which stipulates a flat rate for all work, materials, equipment supplies, installation and engineering services.

In this project, Voith Siemens Hydro is working for the CHA-Hydroelectric Consortium of Aimorés, consisting of the partners "Vale do Rio Doce", the largest Brazilian mining and logistics company, and the Brazilian electricity company CEMIG, Companhia Energética de Minas Gerais.

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# Last step to digital governors at Danube hydropower stations

Voith Siemens Hydro of Austria was recently awarded the 3.5 million Euro contract for automating four Danube power plants, thus continuing its successful collaboration with Austria's largest producer of electric power, VERBUND. Voith Siemens Hydro has already installed digital governors in four of VERBUND's nine run-of-river power plants. These generate a total of more than 12 billion kWh, which accounts for approximately one quarter of Austria's total power production. The order for Aschach, Wallsee, Ybbs, and Altenwörth power stations includes the delivery of 25 digital governors, speed sensing and feedback transmitters, the reconstruction of both control valves and the shutdown circuit. The first unit will be commissioned at the beginning of 2004, the complete refurbishment of all power plants should be finished by the end of 2008.

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Photos: Courtesy of VERBUND Austria

## Aschach

Type: Run-of-river
Production in a normal year: 1,617.4 million kWh
Nominal capacity: 287,400 kW
Units: 4
Turbines: vertical Kaplan
Mean gross head: 15.3 m
Maximum flow: 2,040 m <sup>3</sup> /s
Weir system: 5 weir openings
Navigation locks: 2 (230 x 24 m)
Barrage length: 40 km
Initial construction period: 1959-64
Province: Upper Austria

## Wallsee

Type: Run-of-river
Production in a normal year: 1,318.8 million kWh
Nominal capacity: 210,000 kW
Units: 6
Turbines: vertical Kaplan
Mean gross head: 10.8 m
Maximum flow: 2,700 m <sup>3</sup> /s
Weir system: 6 weir openings
Navigation locks: 2 (230 x 24 m)
Barrage length: 25 km
Initial construction period: 1965-68
Province: Lower Austria/Upper Austria

# *New control system for Germany's Friedrichsau*

## **Ybbs**

Type: Run-of-river

Production in a normal year:

1,335.9 million kWh

Nominal capacity: 236,500 kW

Units: 7

Turbines: 6 vertical Kaplan

1 horizontal Kaplan bulb

Mean gross head: 10.9 m

Maximum flow: 2,650 m<sup>3</sup>/s

Weir system: 5 weir openings

Navigation locks: 2 (230 x 24 m)

Barrage length: 34 km

Initial construction period: 1954-59

Province: Lower Austria

## **Altenwörth**

Type: Run-of-river

Production in a normal year:

1,967.6 million kWh

Nominal capacity: 328,000 kW

Units: 9

Turbines: horizontal Kaplan bulb

Mean gross head: 15 m

Maximum flow: 2,700 m<sup>3</sup>/s

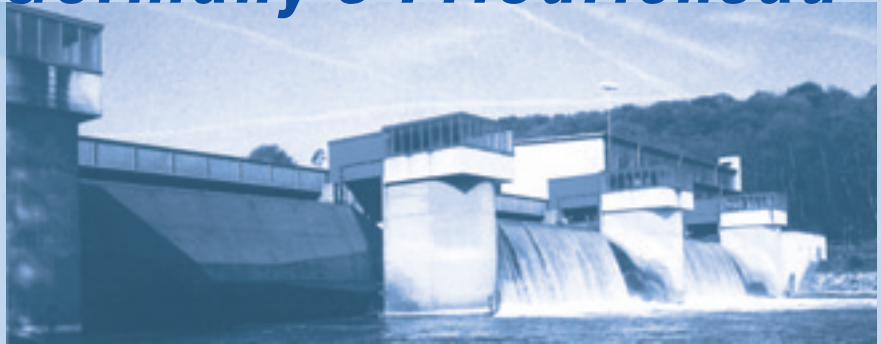
Weir system: 6 weir openings

Navigation locks: 2 (230 x 24 m)

Barrage length: 30 km

Initial construction period: 1973-76

Province: Lower Austria



In May 2003, SWU (Ulm Municipal Works) entrusted Voith Siemens Hydro with the delivery of a new control system for its Friedrichsau hydropower station. This project further consolidates a cooperation, which had its successful beginnings with the modernization of the Donaustetten hydropower plant.

The Voith Kaplan turbine has been in trouble-free service at Friedrichsau hydropower station for the past 50 years. Each year its generators produce almost 50 million kWh of energy, approximately the power for an average of 14,000 households.

A new control system will now transfer the system to automatic operation as early as October 2003. This represents a very short delivery time, made possible by the standardized modules of the VSHycon Efficient System and the continuing partnership between SWU and the specialists at Voith Siemens Hydro.

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Technological leadership

## *Opening ceremony at Europe's most modern pumped storage plant*

On 30th September 2003, Goldisthal in Thuringia, Germany, at present Europe's most advanced pumped-storage plant, received its official acceptance for commercial operation. Including Germany's Chancellor Gerhard Schröder and the Prime Minister of Thuringia, Dieter Althaus, the owner and operator Vattenfall Europe AG welcomed numerous government officials and industry leaders to the inauguration.



*CEOs are pleased about the Voith Siemens Hydro gifts for the Goldisthal visitor center from left to right: Reinhardt Hassa, Vattenfall and Dr. Hermut Kormann, Voith AG*





Dr. Hermut Kormann, President and Chief Executive Officer of Voith AG, presented a component of the variable-speed pump-turbine model runner as well as graphic displays for the visitor center to Reinhardt Hassa, Member of the Board of Vattenfall Europe Generation AG & Co. KG, and chief charge of the Corporate Division "Power Stations".

It took six years to build this pumped-storage project – from the ground breaking for the access tunnel into the cavern to initial start-up of commercial operation of the first of four pump-turbine units in February 2003 and the official opening ceremony.

The construction and operation of Goldisthal will secure 50 permanent power station jobs and approximately

80 related industrial jobs in the Thuringia region. Moreover, the project has also resulted in an additional flood protection area and water reservoir of 2.9 million m<sup>3</sup> for use in dry periods.

The pump-turbines, each rated at 265 MW, were supplied in a consortium with VA Tech Hydro and CKD Blansko Engineering, in which Voith Siemens Hydro Power Generation was primarily responsible for the hydraulic design and the entire control system, including the technology of variable-speed turbine control installed in two of four machines. With its advanced technology, Goldisthal is setting several international standards, including: the gigantic machines can be synchronized to the grid from standstill to full power in record time in world comparison.

Another novelty for European pumped-storage plants: two of the four machines operate in "variable-speed" mode and for this reason variations in the electrical grid can be balanced much easier than with traditional pump-turbine units.

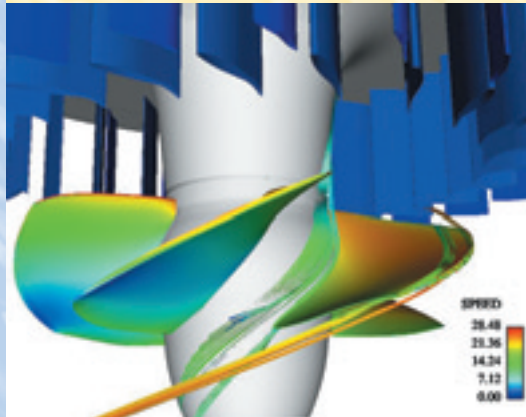
Goldisthal pumped-storage plant is expected to reduce peak load deficits and to provide a reserve for losses of larger power station blocks in the Vattenfall grid. These features make a significant contribution to the safe operation of the grid. At maximum head, each pump-turbine can produce 325 MW of clean, renewable energy.

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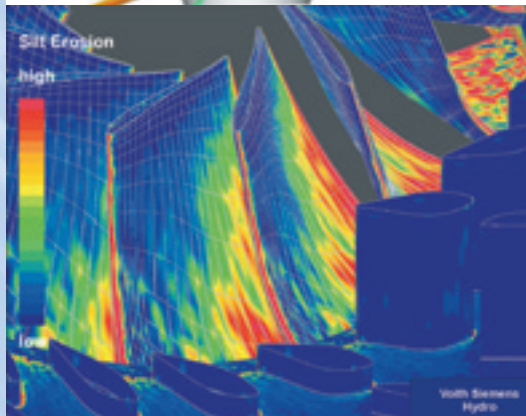
# Research to reduce hydro-abrasive wear

After more than six years, the German-financed research program on requirement-based coating in Chinese hydropower plants has led to new findings, both on how to reduce the effect of hydro-abrasive wear by erosion prediction and also on erosion protection. In addition to laboratory-based examinations, the real scale performance of the measures to reduce wear was tested at the San Men Xia hydropower plant in Henan Province, China. The project, financially supported by the German BMFT (Federal Ministry for Research and Technology), had a considerable volume.

Particle trajectories in a Kaplan turbine and local flow velocity



Prediction of hydro abrasive wear on a Francis runner



Hydropower plants located at rivers carrying an extremely high amount of abrasive particles during the flood seasons have to deal with the severe situation of hydro-abrasive erosion. This is still a major obstacle to the economic utilization of hydropower resources in those countries. The aim of the aforementioned research project had been a comprehensive program to develop up-to-date measures against silt erosion.

## Optimized hydraulic shape

Different approaches are possible to reduce wear in hydraulic turbines. It is not always possible to carry out catchment area treatment to avoid abrasive particles being washed into the river water or to remove particles before entering the hydro turbine. Nevertheless, a solution had to be found to reduce the damage by abrasive particles. During the research project, a process was developed to modify the hydraulic shape of turbines and significantly reduce hydro-abrasive erosion. This is performed by highly developed CFD tools (Computational Fluid Dynamics), which optimize the hydraulic design by determining "hot spots" of hydro abrasive wear.



*Application of the Diaturb® 532 coating*

*Combination of different coating systems*

Areas are indicated, where the wear rate reaches extremely high values. At this stage of the engineering process, design changes can be made and modifications can be implemented easily. The main emphasis is on achieving a more homogenous hydro-abrasive erosion on the hydraulic surface of the component, rather than having local “hot spots”. At the end of the process an optimized design is achieved, both in regard to hydraulic behavior and erosion prevention. These measures can only reduce the erosion attack, but not completely prevent it.

#### **Material-based solutions**

The second goal of the project was to develop a material-based solution to protect the surface of hydraulic components. Material tests were carried out to examine available base

materials and coatings in order to obtain a rating of wear-related properties.

Two groups of materials, each relying on completely different protection mechanisms, were clearly dominating the high end of this classification. Based on the experiments and examinations, two materials, one from each group, were selected for the pilot applications on the Yellow River. A “hard”, HVOF-applied TC/CoCr coating (High Velocity Oxygen Fuel), named Diaturb® 532, and a “soft” PU-based coating, Softurb® 80, were chosen to protect the pilot turbine and its components from hydro-abrasive erosion.

The San Men Xia research project included a monitoring phase of two years, during which the turbine parts were inspected several times. The unit was

also in operation during the flood seasons with an average sand concentration of 20-30 kg/m<sup>3</sup>. At the end of this phase the protection systems had fulfilled the requirements. The combination of erosion prevention by design optimization and coating-based erosion protection, lead to a significant reduction in wear.

On an overall basis, the result of the research project is very satisfying. Wear rates at the newly designed and protected surfaces are minimal compared to the original runner parts. The experience from the research project was included in a process improvement of the protection systems.

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## Customer contacts

# Infra 2020: Sponsoring the third Brazilian Forum of Electric Energy

Voith Siemens Hydro Brazil was one of the main sponsors of the third Brazilian Forum of Electric Energy which took place on July 7 and 8 in São Paulo. Under the title “Infra 2020”, more than 500 Brazilian and international executives from the electric energy sector discussed the country’s future generation, transmission, distribution and commercialization of energy issues.

The forum of 25 private and state-owned companies of suppliers, investors, etc. clearly succeeded in

drawing the Brazilian government’s attention to the current problems in the country’s energy sector. A signifi-

cant lack of private investment, which is threatening to bring a new energy crisis, was identified as the central problem to be addressed.

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# ERLAC X prizes for best paper presentations

During the biannual gathering of ERLAC – the regional Latin American meeting of CIGRE from May 18-22, Voith Siemens Hydro São Paulo was honored with three awards for the best case studies presented during the event.

Out of a total number of 28 case studies presented in the session held on rotating machinery showcasing specialties and latest technological development from the companies involved in generation, transmission and distribution

of electrical energy, Voith Siemens Hydro presented fourteen. The winners were Jorge J. R. Echeverria with “Methods of identification and analysis of problems of electromagnetic origin in the stators of synchronized

machines”, Thomas Hildinger, Joao C. Benedetti and Ciao W. Kramer with their paper on “A new concept for isolation of excitation winding in hydro generators”, and Thomas Hildinger, Marcelo G. Tavares and Joao F. Namoras on “Virtual Assembly”.

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## New brochures

The latest Voith Siemens Hydro brochures are now available:

For more information:  
hydrocontact@vs-hydro.com

t 3033 e



t 3301 e



t 3304 e





# Waterpower XIII, 2003 Very well attended

Waterpower XIII was held at the end of July in Buffalo, New York, USA with a record 1,400 participants compared to the expected 900 attendance. The close proximity to the world renowned Niagara Falls presented the opportunity to celebrate a special anniversary for Voith Siemens Hydro – the 100th anniversary of the installation of Voith turbines at Niagara Falls in 1903 with a special leaflet focusing on the historic installation.

Voith Siemens Hydro York's involvement in the bi-annual event as an exhibitor and supporter of the conference with company staff for panel discussions, session leadership and presentation of technical papers played an important part in this successful conference.

Voith Siemens offered a separate exhibit room that allowed in-depth pre-

sentations and discussions with visitors on environmental solutions including fish-friendly and aerating turbines, Integrated Services, WaterView and generator technology.

The company sponsored social events included a conference wide reception held at the New York Power Authority's Robert Moses Power Vista. It also held a special customer event in the

historic Buffalo and Erie Historical Museum. One hundred forty guests were entertained in the only remaining permanent structure from the 1901 Pan American Exposition.

Wolfgang Heine, Executive Vice President and General Manager took the opportunity to address the guests and say a personal farewell to his customers as he prepared to retire and leave the Board of Voith Siemens Hydro York at the end of the year. Mr. Heine also introduced the new Directors. (see next article)

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## Voith Siemens Hydro, USA, names new officers



E. Mark Garner

Brian Greenplate

Wolfgang Heine

Voith Siemens Hydro Power Generation Inc. has named E. Mark Garner its President and Brian Greenplate, Executive Vice President.

Mark Garner joined the company as plant manager in 1988. He served as Vice President of turbine operations until 1999, when he was promoted to

Executive Vice President. He became President on October 1, 2003. Brian Greenplate was previously the Vice President for Sales and Marketing and assumed his new position as Executive Vice President on March 1, 2003.

Wolfgang Heine, Executive Vice President and General Manager, will retire at the end of 2003. He spent the past 14 years at Voith Hydro and Voith Siemens Hydro Power Generation in York.

# *The sound of the waves*



**Water – the elixir of life. Life on the continent that has seen human settlement longer than any other has always been governed by this fundamental insight. In Africa, people are conscious in every aspect of their existence of the extent to which they depend on this element. It is therefore hardly surprising that water occupies a central position in their culture and in every area of what we have come to know as the fine arts.**

Some anthropologists are of the opinion that music has its origins in the very heart of the this continent. Even today, music and dance are a traditional accompaniment to every important situation in day-to-day life. Music coordinates the work processes and provides rhythm, dancing to music has a mystic power and, for example when the planting season comes around, is used to call for the rain needed for the crops to grow. Many of the songs handed down from one generation to the next describe the strength and might of water.

In the Western world, at least in regions that do not suffer from a shortage of water, this element has acquired a lively, jovial character in music, reflecting the more positive character attributed to it. In North America, many music-lovers are convinced that the blues would not have come about without the influence of a mighty river. The lower reaches of the Mississippi are regarded as the birthplace of America's entire culture of popular music.



Many internationally successful artists in these musical categories have put forward this theory. Powerful performers such as Ike and Tina Turner, John Lee Hooker or Luther Allison all obtained their inspiration from the Mississippi Delta and became in their turn the icons and models of several later generations of musicians.

In Europe's musical history there have been many examples of water being transferred from the river or seabed to the musical score, one of the best-known is "Vltava" ("The Moldau") by Bedrich Smetana, who was born in Eastern Bohemia in 1824.

This tone poem, lasting twelve minutes, describes how the river flows from the two springs that are its source – represented by warbling flutes and clarinet runs – until it grows in size and passes through the woods and fields – a famous melody – and reaches the dangerous rapids of St. John, dramatically portrayed by passages by the stringed instruments. Finally, the Moldau emerges proudly from these conflicts of the elements to join other mighty streams on their way to the sea.

Georg Friedrich Händel (1685-1759) has left us a splendid aural example of water at its most impressive. With all the tonal opulence of the baroque

period, he wrote his celebrated "Water Music", dedicated it to the British King George I and arranged for it to be performed on the River Thames in 1717.

Another musical theme from the world of water bade fair to become the rallying song of an entire generation. "Aquarius", the best-known song from the musical "Hair", announced the "dawning of the age of Aquarius". This sign of the zodiac and the influence of the planet Uranus were taken by the "flower-power" movement as their inspiration to "make love, not war" in the hope that a better world would come about and that a protest against all forms of violence could be organized.

Even this brief selection from a topic-area that is almost unlimited in its scope shows us that water is an existential topic and plays a significant part in the artistic heritage of all the world's cultures.



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